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Abundance and Run Timing of Salmon in Blue Bill and Red Salmon Creeks, Izembek National Wildlife Refuge, 2005

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Cheryl A. Dion

Abstract

A bi-directional fixed picket weir was installed and operated within Izembek National Wildlife Refuge on Red Salmon Creek (RS) from 26 June to 21 September and on Blue Bill Creek (BB) from 10 July to 21 September 2005. Underwater digital video equipment and microwave technology were used to simultaneously monitor fish passage on both streams from a single location. Sockeye salmon *Oncorhynchus nerka* was the most abundant species counted through the weirs with 18,288 fish passing Red Salmon Creek and 12,690 fish passing Blue Bill Creek. The main migration began in mid July and continued until mid September with a peak in late August. Coho salmon *O. kisutch* were the next abundant species (RS=2,455 and BB=362). The main migration began in late August and continued until the weirs were pulled on September 21. The run in Red Salmon Creek peaked in mid September. Other fish passing the weir included pink *O. gorbuscha* (RS=11 and BB=7) and chum salmon *O. keta* (RS=64 and BB=81), Dolly Varden *Salvelinus malma*, and whitefish *Coregonus spp.*

Introduction

The Alaska National Interest Lands Conservation Act (ANILCA) specifically mandates that in Izembek National Wildlife Refuge fish and wildlife populations and their habitats be conserved and managed in their natural diversity (USFWS 1985). The conservation of Pacific salmon stocks that are exploited in commercial, subsistence or sport fisheries require accurate monitoring of escapements. Escapement monitoring provides fisheries managers with data to better manage limited resources. In-season escapement estimates of sockeye *Oncorhynchus nerka* and coho *O. kisutch* salmon near Cold Bay are lacking. The Alaska Department of Fish and Game (ADFG) have expressed concerns that this lack of information may jeopardize the health of the runs, as well as opportunities for subsistence and sport fishing (Arnold Shaul, ADFG, personal communication). The ADFG conducts aerial surveys to monitor Pacific salmon escapement in systems near Cold Bay. However, the effectiveness of these aerial surveys are limited by dark stream bottoms, turbid water, and inclement weather. In 2003, the ADFG counted over 13,000 sockeye and 1,100 coho salmon in Blue Bill Lake, and over 5,000 sockeye, 1,300 coho, and 500 chum salmon *O. keta* in the Red Salmon Creek watershed (Murphy et al. 2004). Adams et al. (1993) documented the presence of coho, sockeye, chum, and pink salmon *O. gorbuscha* in the study streams and lakes. Given the importance of salmon runs to local sport and subsistence users, the U. S. Fish and Wildlife Service, King Salmon Fish and Wildlife Field Office (KSFO) installed a bi-directional weir to monitor sockeye and coho salmon escapement in Red Salmon and Blue Bill creeks. To minimize the potential impacts on fish and the environment in these remote locations, underwater digital video equipment and microwave technology were used to simultaneously monitor fish passage on both streams from a single location. The objectives of this study were to estimate abundance and describe the run timing of Pacific salmon in Red Salmon and Blue Bill creeks.

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Study Area

Red Salmon and Blue Bill creeks are small watersheds on Izembek National Wildlife Refuge near the community of Cold Bay on the Alaska Peninsula (Figure 1). The Red Salmon Creek watershed has two interconnected lakes, Lake Trelford and Lake Hess, and discharges into the Moffett Lagoon region of Izembek Lagoon. Blue Bill Creek is the outlet stream of Blue Bill Lake and discharges into the Applegate Cove region of Izembek Lagoon. The small creeks are less than 3 meters across and less than 1 meter in depth at each weir site. Both creeks are relatively clear but at times have less than 25 cm visibility.

Methods

The KSFO installed and operated a bi-directional fixed picket weir from 26 June through 21 September 2005 on Red Salmon Creek and from 10 July to 21 September 2005 on Blue Bill Creek. The weirs were installed near the lake outlets on both creeks, and were above the upstream influence of tidal flows. The weir panels were constructed from 12 mm diameter electrical metal conduit separated by 38 mm lengths of polyvinyl chloride pipe, and joined together with 4 mm diameter galvanized aircraft cable. An 8 mm diameter aircraft support cable was strung across the creeks about 0.3 m above the surface of the water and anchored to the creek banks. The creek banks at each end of the weir were reinforced with sandbags to prevent erosion and a strip of Amoco® geotextile cloth was anchored beneath the weirs to prevent substrate erosion. Fence posts were used to provide additional support for the weir panels. A video passage chute was attached to each weir and panels were installed on the upstream and downstream side of the chute. The weirs were visually inspected and maintained daily at a minimum, or more often as necessary to insure integrity.

The video monitoring system at each weir consisted of an Applied Microvideo Model 10 underwater video camera. Each camera was mounted in a sealed aluminum camera box with a clear safety-glass window. The camera box was filled with filtered water treated with algaecide. The distance between the camera lens and the glass window provided separation between fish and the camera lens. In turbid water, image quality is maintained as the majority of the distance between fish and the lens is within the filtered water contained in the video box. Two adjustable 12-v lights with articulated arms were installed inside the camera box to provide illumination. The camera box was attached to the fish passage chute that provided a controlled lighting environment for the underwater camera to prevent fluctuations in light from external conditions. A baffle was installed inside the chute to lead the fish closer to the glass and enhance fish identification in turbid water. The distance between the baffle and the glass was about 15 cm.

The camera at Red Salmon Creek was connected to a Sanyo DSR-3510 multi-channel digital video recorder (DVR) and the camera at Blue Bill Creek was connected to a microwave transmitter. The microwave transmitter at Blue Bill Creek transmitted a signal to a microwave repeater site which transmitted a signal to a microwave receiver set up at Red Salmon Creek. The repeater site was set up on a hilltop such that line-of-sight signals were possible between the weir sites and the repeater. The video signal received from Blue Bill Creek was connected as a separate channel to the DVR. The DVR processed video from both streams simultaneously using motion detection hardware and software. The motion detection was used to eliminate blank footage, and digitally record footage containing fish for later counting and identification.

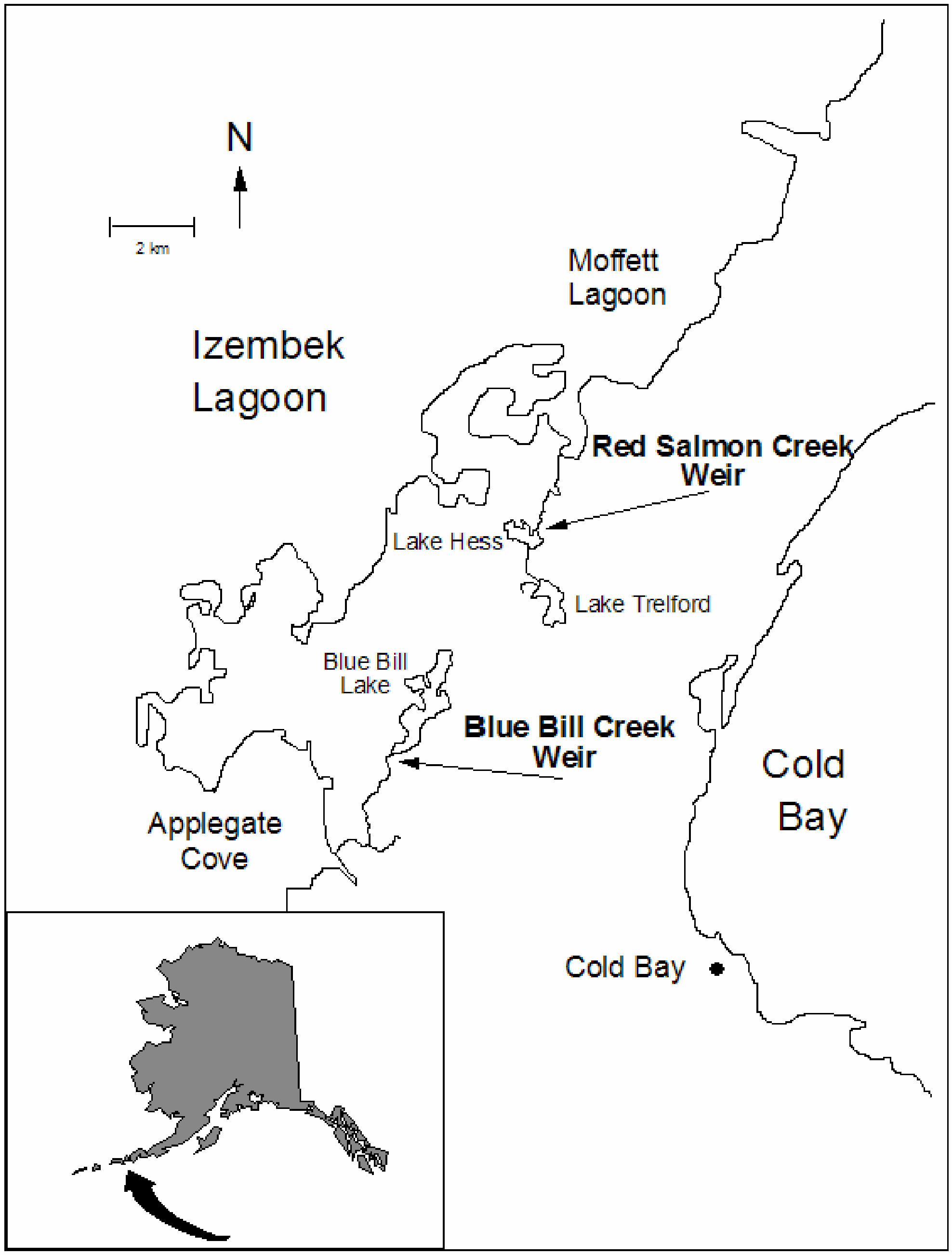

Figure 1. The weir locations near Cold Bay, Alaska on Izembek National Wildlife Refuge. Numerous water bodies have been omitted for clarity.

Recorded files of fish passage were reviewed on a daily basis, and all Pacific salmon passing upstream and downstream were identified to species and enumerated. Archived footage was copied to DVD-RAM media and to an 8 mm camcorder. The video signal cable at Blue Bill Creek was connected to a GYYR DVMS 400 multi-channel DVR while reviewing video footage, to ensure that fish did not passed undetected. The motion detection was set up to record Pacific salmon only.

Fish were passed through a passage chute and counted using digital video equipment. The passage chute was originally designed to remain open 24 hours per day to allow upstream and downstream fish passage. However, erratic fish behavior at night resulted in constant triggering of the motion detection and almost continuous alarm recording. Therefore, motorized gates were installed on the downstream end of each passage chute and were controlled by electronic timers. The gates were closed at 2200 hours and opened at 0700 hours.

A Hobo® temperature data logger was installed at each weir to monitor water temperatures. Water temperature was recorded every two hours and later summarized as daily maximum, mean, and minimum.

Results

Red Salmon Creek

Weir operation began on 26 June and continued through 21 September 2005. Sockeye salmon were the most abundant species counted through the weir (*N*=18,288) followed by coho (*N*=2,455), chum (*N*=64), and pink salmon (*N*=11) (Appendix A). Dolly Varden *Salvelinus malma* and whitefish *Coregonus spp*. were observed but not counted. Sockeye salmon were counted at the weir from 26 June to 21 September, with a peak of 1,841 (or 10% of the run) passing the weir on 18 August (Figure 2; Appendix A). Coho salmon were counted at the weir from 18 August to 21 September, with a peak of 1,951 (or 22% of the run) passing the weir on 18 September (Figure 3; Appendix A). Sockeye and coho salmon were still being counted at the weir when it was removed on 21 September.

The motion detection was not triggering every fish between 5-7 July and 11-13 July. The crew had difficulty counting fish during nighttime hours on 8-9, and 13-14 August. The wind generator broke 19 August and was down until 13 September. On 19 August the weir was not fish tight and on 23-24 August the passage gate did not close. The camera went dark on 20-21 August (14 hours). Various power outages occurred between 26 June to 7 July, and on 25, 27, 28 August, and 15 and 17 September resulting in approximately 42 hours of lost footage at both weir sites.

Blue Bill Creek

Weir operation began on 10 July and continued through 21 September 2005. Sockeye salmon were the most abundant species counted through the weir (*N*=12,690) followed by coho (*N*=362), chum (*N*=81), and pink salmon (*N*=7) (Appendix B). Dolly Varden and whitefish were observed but not counted. Sockeye salmon were counted at the weir from 13 July to 21 September, with a peak of 1,050 (or 8% of the run) passing the weir on 10 August (Figure 2; Appendix B). Coho salmon were counted at the weir from 25 August to 21 September, with a peak of 54 (or 15% of the run) passing the weir on 20 September (Figure 3; Appendix B). Sockeye and coho salmon were still being counted at the weir when it was removed on 21 September.

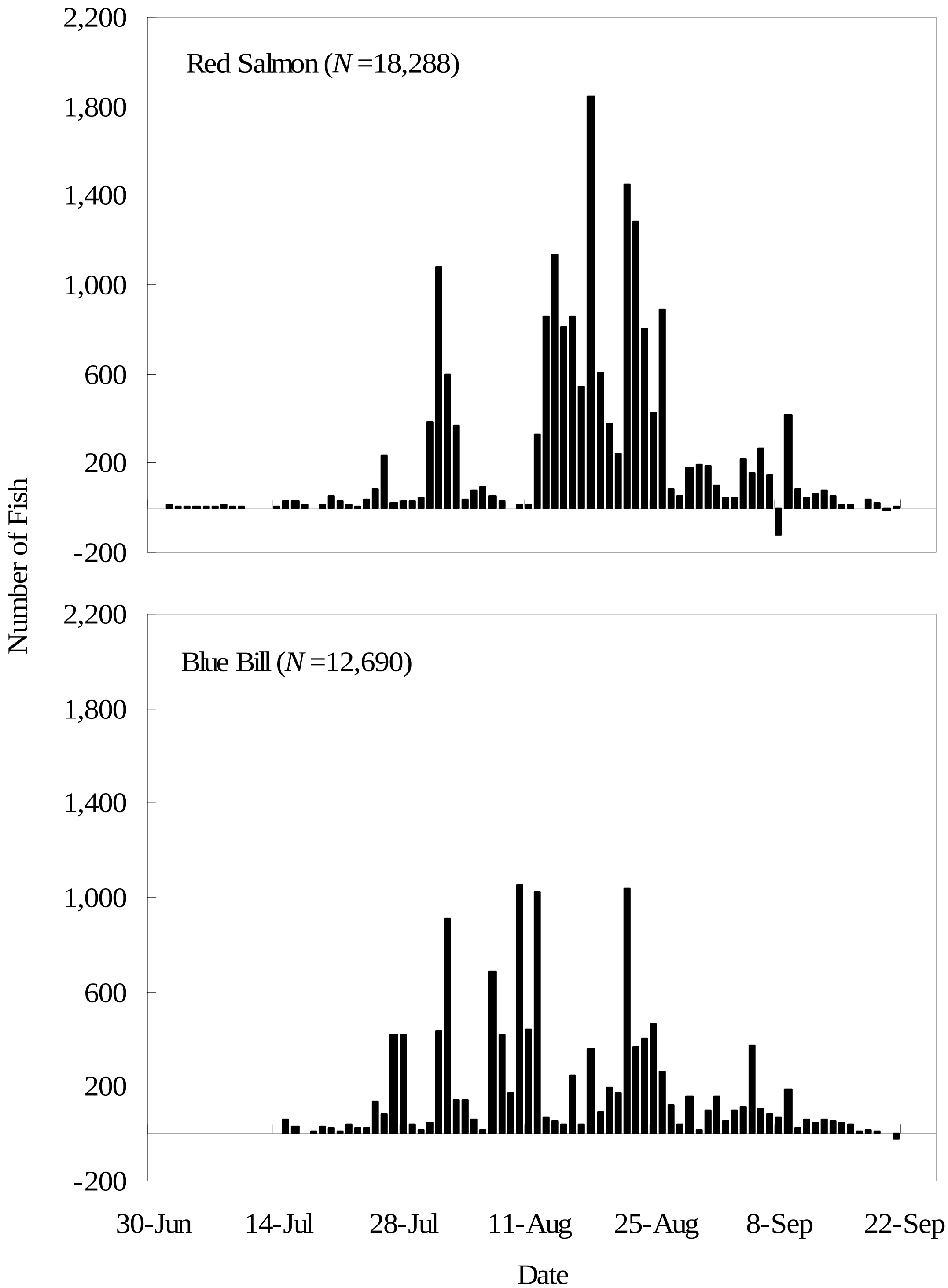

Figure 2. Daily counts of sockeye salmon at the Red Salmon Creek and Blue Bill Creek weirs, 2005.

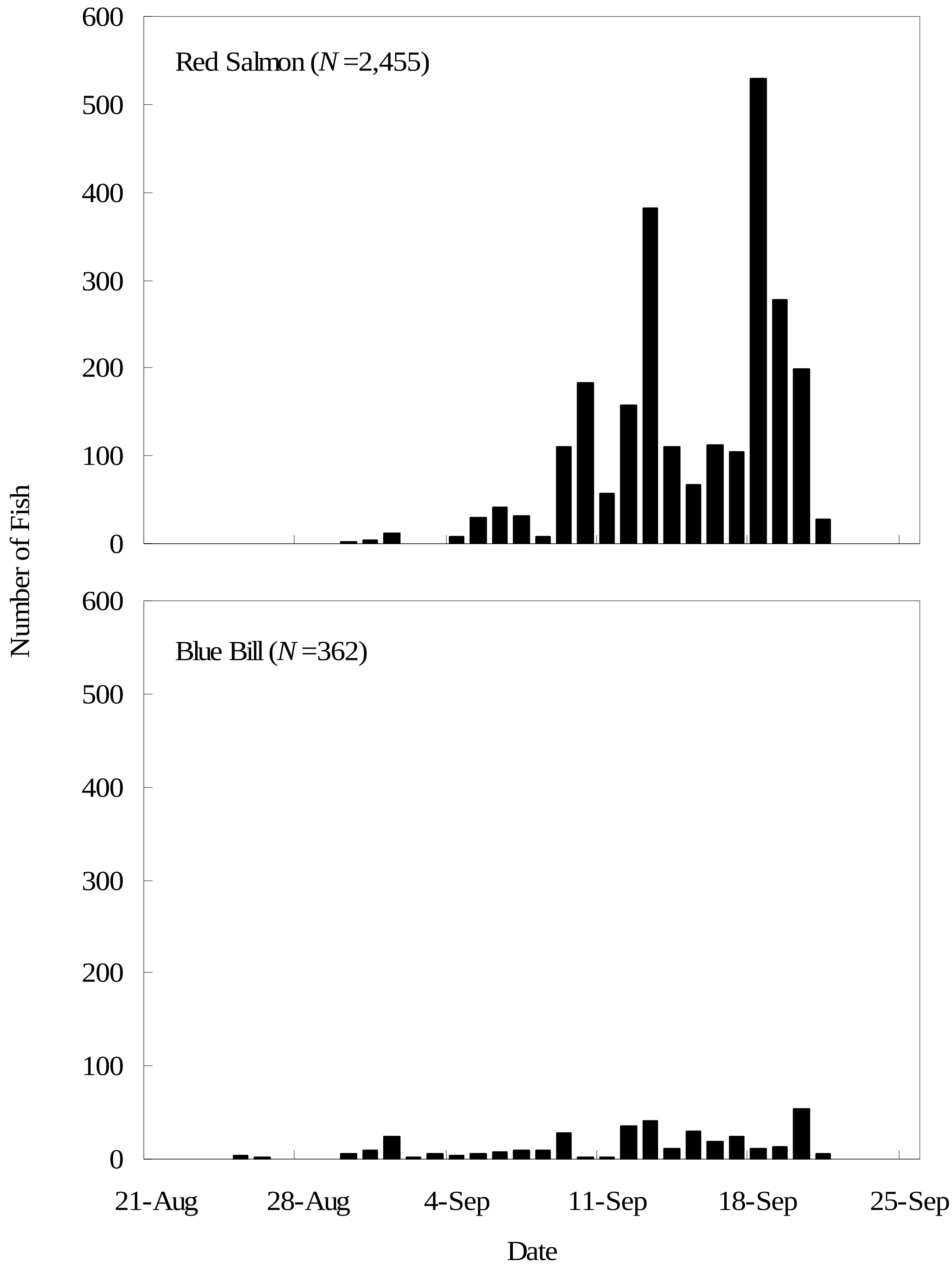

Figure 3. Daily counts of coho salmon at the Red Salmon Creek and Blue Bill Creek weirs, 2005.

The DVR did not record footage or function properly to be able to review footage on 27 July, 3 and 5 August (5.5 hours).

Water temperatures in Blue Bill Creek were greater overall throughout the summer compared to Red Salmon Creek (Figure 4). The temperature data logger was observed close to the surface on several occasions and on the surface 26 July and 4 August. Maximum water temperature in Red Salmon Creek was 17.8 and 19.4ºC in Blue Bill Creek.

Discussion

Sockeye salmon were captured the first day after the weir was installed at Red Salmon Creek and a few days after installation at Blue Bill Creek. Since only a few fish passed the weir in the first few days of operation, it is reasonable to assume that few sockeye salmon passed upstream prior to installation. Small numbers of sockeye and coho salmon were still passing the weir in the week prior to removal. Therefore, it is likely that part of the late run was missed and salmon counts were underestimated. However, undercounting was more likely a concern due to power outages, erratic fish behavior at night, and DVR or motion sensing issues. Lack of wind for the wind generator attributed to the majority of power outages. The gas generator was run for several hours during the day, but on unusually calm days, the power consumption (>5,000 watts per day) exceeded the amount generated at Red Salmon Creek.

Counting fish during nighttime hours was and continues to be problematic (Anderson et al. in preparation). Fish would swim into the lighted passage chute, but were reluctant to leave into the dark environment upstream. Fish would behave erratically, darting around the chute which resulted in constant triggering of the motion detection and almost continuous alarm recording. Motorized gates were installed on the downstream end of each passage chute on 22 August to alleviate this problem. The gates were controlled by electronic timers and were closed during nighttime hours to prevent fish from passing. Reviewing video and counting fish improved after installation of the gates, however, this was not an ideal solution because fish were prevented from passing the weir 24 hours per day. Programming the timers to open and close at multiple time intervals during the night may have allowed fish to move more freely and may minimize the potential for fish to back up behind the weir. To reduce erratic nighttime movement, the use of infrared light may be a possible alternative to halogen light (Beach 1978, Hinch and Collins 1991, Grant et al. 2004).

Early on in the project the crew had difficulty setting the motion detection accurately. The sensors were either set too high, resulting in extensive amounts of video to view from frequent triggering of light, water and small fish, or too low to detect all Pacific salmon that passed. This happened during low passage times and probably had little impact on fish counts. The crew was unable to view video from the DVR on several occasions. This was most likely because the recording settings were set incorrectly or the lights were accidentally turned off.

Species misidentification did not appear to be a problem because the quality of the video was good, enabling accurate identification of fish. Initially, there was some concern that bright chum salmon would migrate past the weir and the crew would have difficulty discerning the correct species. This did not turn out to be a problem. Chum salmon had metamorphosed into their spawning colors by the time they reached the weirs.

Ambient light entering the fish passage chute was and continues to be an issue on sunny days. The light triggers the motion detection and washes out the video image. Boards were installed to

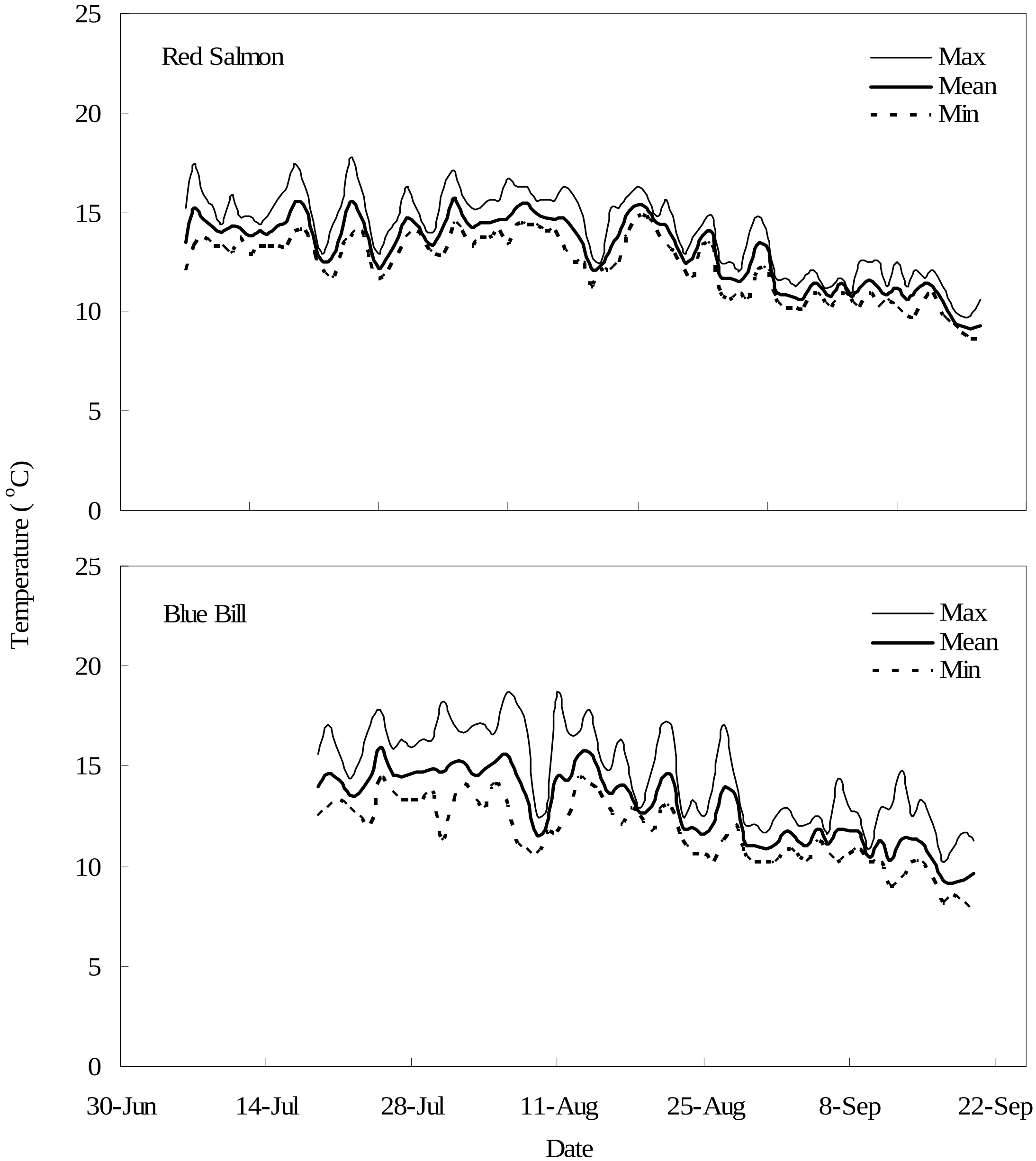

Figure 4. Maximum, mean, and minimum daily water temperatures in Red Salmon and Blue Bill creeks, 2005.

extend the passage chute and reduced the amount of ambient light entering the chute. This reduced the number of alarms triggered, but the video image was still slightly washed out. Extending the length of the video chute or developing a fabric sun shade may help reduce ambient light from entering the chute and affecting camera exposure. However, this may not be a feasible alternative in small streams where space is restricted. Recording video simultaneously was not problematic unless both systems had large numbers of fish moving through the passage chute. This appeared to overload the motion detection program resulting in continuous video recordings from both sites.

The microwave equipment operated extremely well throughout the project and a major benefit of the microwave link was the reduced power consumption in the field. Loss of power attributed to the majority of problems at Red Salmon Creek. By not having a monitor and digital video recorder at Blue Bill Creek the power needs were reduced by half, thus reducing the probability of power failures. The microwave link equipment also provided an opportunity to further reduce labor costs, as we were able to run two weir projects with only one field crew. Ideally the microwave link would allow us to transmit the video to the office, eliminating exposure of sensitive electronic equipment to field conditions and further minimize potential impacts on the environment.

Water temperatures in Blue Bill Creek were greater overall throughout the summer compared to Red Salmon Creek. This was most likely due to shallow depth of water at the Blue Bill Creek weir site. However, the temperature data logger was observed close to the surface on several occasions or on the surface (26 July and 4 August) which may have attributed to some of the higher maximum water temperatures.

Based on a single aerial survey in 2005, the Alaska Department of Fish and Game estimated sockeye salmon escapement in Red Salmon Lake to be 9,400 and 6,300 in Blue Bill Lake (Joe Dinnocenzo, ADFG, personal communication). Given that the weir counts were greater than the aerial survey counts, the discrepancy between weir and aerial counts suggests that there are far greater numbers of sockeye salmon entering both creeks that previously estimated. However, caution should be used when making assumptions about the escapement estimates from this one year study. No aerial surveys were conducted on coho salmon in 2005. These systems should be monitored and assessed again in ten years to ensure the health of the populations, allow better judgment of abundance trends, and obtain information on returns resulting from escapements.

Acknowledgements

I wish to thank the many people who helped with field work: Anderson Berry, Zach Brock, Andy Glass, Jade Helmich, Pam Loring, Lisa OGawa, and Kurt Segerberg. I also thank the staff at the Izembek National Wildlife Refuge, Alaska Department of Fish and Game and Alaska Science Center for logistical support.

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Appendix A. Summary of Pacific salmon passage at the Red Salmon Creek weir, 2005.

	Sockeye		Coho		Chum		Pink	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
26-Jun	1	1	0	0	0	0	0	0
27-Jun	0	1	0	0	0	0	0	0
28-Jun	0	1	0	0	0	0	0	0
29-Jun	0	1	0	0	0	0	0	0
30-Jun	1	2	0	0	0	0	0	0
1-Jul	0	2	0	0	0	0	0	0
2-Jul	11	13	0	0	0	0	0	0
3-Jul	4	17	0	0	0	0	0	0
4-Jul	6	23	0	0	0	0	0	0
5-Jul	3	26	0	0	0	0	0	0
6-Jul	5	31	0	0	0	0	0	0
7-Jul	8	39	0	0	0	0	0	0
8-Jul	10	49	0	0	0	0	0	0
9-Jul	8	57	0	0	0	0	0	0
10-Jul	5	62	0	0	0	0	0	0
11-Jul	0	62	0	0	0	0	0	0
12-Jul	0	62	0	0	0	0	0	0
13-Jul	1	63	0	0	0	0	0	0
14-Jul	4	67	0	0	0	0	0	0
15-Jul	32	99	0	0	0	0	0	0
16-Jul	29	128	0	0	0	0	0	0
17-Jul	14	142	0	0	0	0	0	0
18-Jul	1	143	0	0	0	0	0	0
19-Jul	16	159	0	0	0	0	0	0
20-Jul	52	211	0	0	0	0	0	0
21-Jul	31	242	0	0	0	0	0	0
22-Jul	13	255	0	0	0	0	0	0
23-Jul	3	258	0	0	0	0	0	0
24-Jul	39	297	0	0	0	0	0	0
25-Jul	88	385	0	0	0	0	0	0
26-Jul	231	616	0	0	0	0	0	0
27-Jul	22	638	0	0	0	0	0	0
28-Jul	31	669	0	0	0	0	0	0
29-Jul	31	700	0	0	0	0	0	0
30-Jul	43	743	0	0	0	0	0	0
31-Jul	382	1,125	0	0	0	0	0	0
1-Aug	1,076	2,201	0	0	1	1	0	0
2-Aug	600	2,801	0	0	1	2	0	0
3-Aug	372	3,173	0	0	0	2	0	0

Appendix A. Continued.

Date	Sockeye Daily	Sockeye Cum	Coho Daily	Coho Cum	Chum Daily	Chum Cum	Pink Daily	Pink Cum
4-Aug	38	3,211	0	0	0	2	0	0
5-Aug	75	3,286	0	0	0	2	0	0
6-Aug	93	3,379	0	0	0	2	0	0
7-Aug	51	3,430	0	0	0	2	0	0
8-Aug	27	3,457	0	0	0	2	0	0
9-Aug	-5	3,452	0	0	0	2	0	0
10-Aug	15	3,467	0	0	0	2	0	0
11-Aug	12	3,479	0	0	0	2	0	0
12-Aug	330	3,809	0	0	0	2	0	0
13-Aug	856	4,665	0	0	1	3	0	0
14-Aug	1,133	5,798	0	0	2	5	0	0
15-Aug	809	6,607	0	0	0	5	0	0
16-Aug	858	7,465	0	0	0	5	0	0
17-Aug	540	8,005	0	0	0	5	0	0
18-Aug	1,841	9,846	1	1	0	5	0	0
19-Aug	609	10,455	0	1	0	5	0	0
20-Aug	373	10,828	0	1	1	6	0	0
21-Aug	241	11,069	0	1	2	8	0	0
22-Aug	1,453	12,522	0	1	5	13	3	3
23-Aug	1,283	13,805	0	1	4	17	0	3
24-Aug	802	14,607	0	1	4	21	0	3
25-Aug	420	15,027	0	1	4	25	0	3
26-Aug	889	15,916	0	1	2	27	0	3
27-Aug	88	16,004	0	1	0	27	0	3
28-Aug	50	16,054	0	1	2	29	0	3
29-Aug	177	16,231	0	1	1	30	0	3
30-Aug	194	16,425	2	3	0	30	0	3
31-Aug	189	16,614	3	6	1	31	1	4
1-Sep	100	16,714	12	18	2	33	0	4
2-Sep	42	16,756	0	18	1	34	0	4
3-Sep	45	16,801	0	18	0	34	3	7
4-Sep	222	17,023	8	26	4	38	0	7
5-Sep	156	17,179	30	56	0	38	3	10
6-Sep	267	17,446	41	97	0	38	-1	9
7-Sep	148	17,594	31	128	1	39	0	9
8-Sep	-122	17,472	8	136	5	44	-1	8
9-Sep	418	17,890	111	247	8	52	0	8
10-Sep	81	17,971	182	429	0	52	0	8
11-Sep	43	18,014	58	487	2	54	1	9

Appendix A. Continued.

	Sockeye		Coho		Chum		Pink	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
12-Sep	62	18,076	158	645	1	55	1	10
13-Sep	79	18,155	382	1,027	0	55	0	10
14-Sep	53	18,208	110	1,137	1	56	0	10
15-Sep	13	18,221	67	1,204	0	56	0	10
16-Sep	13	18,234	112	1,316	0	56	0	10
17-Sep	-2	18,232	105	1,421	0	56	0	10
18-Sep	33	18,265	530	1,951	6	62	0	10
19-Sep	21	18,286	277	2,228	1	63	1	11
20-Sep	-7	18,279	199	2,427	0	63	0	11
21-Sep	9	18,288	28	2,455	1	64	0	11

Appendix B. Summary of Pacific salmon passage at the Blue Bill Creek weir, 2005.

	Sockeye		Coho		Chum		Pink	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
10-Jul	0	0	0	0	0	0	0	0
11-Jul	0	0	0	0	0	0	0	0
12-Jul	0	0	0	0	0	0	0	0
13-Jul	2	2	0	0	0	0	0	0
14-Jul	1	3	0	0	0	0	0	0
15-Jul	60	63	0	0	0	0	0	0
16-Jul	31	94	0	0	0	0	0	0
17-Jul	4	98	0	0	0	0	0	0
18-Jul	6	104	0	0	0	0	0	0
19-Jul	28	132	0	0	0	0	0	0
20-Jul	26	158	0	0	-1	-1	0	0
21-Jul	9	167	0	0	-1	-2	0	0
22-Jul	39	206	0	0	0	-2	0	0
23-Jul	22	228	0	0	0	-2	0	0
24-Jul	26	254	0	0	0	-2	0	0
25-Jul	138	392	0	0	0	-2	0	0
26-Jul	86	478	0	0	0	-2	0	0
27-Jul	415	893	0	0	0	-2	0	0
28-Jul	422	1,315	0	0	1	-1	0	0
29-Jul	36	1,351	0	0	1	0	0	0
30-Jul	16	1,367	0	0	0	0	0	0
31-Jul	43	1,410	0	0	0	0	0	0
1-Aug	436	1,846	0	0	3	3	0	0
2-Aug	907	2,753	0	0	1	4	0	0
3-Aug	143	2,896	0	0	0	4	0	0
4-Aug	142	3,038	0	0	0	4	0	0
5-Aug	63	3,101	0	0	1	5	0	0
6-Aug	16	3,117	0	0	0	5	0	0
7-Aug	686	3,803	0	0	0	5	0	0
8-Aug	422	4,225	0	0	0	5	0	0
9-Aug	171	4,396	0	0	1	6	0	0
10-Aug	1,050	5,446	0	0	4	10	0	0
11-Aug	442	5,888	0	0	0	10	0	0
12-Aug	1,021	6,909	0	0	2	12	1	1
13-Aug	67	6,976	0	0	0	12	1	2
14-Aug	53	7,029	0	0	0	12	0	2
15-Aug	35	7,064	0	0	0	12	0	2
16-Aug	248	7,312	0	0	0	12	0	2
17-Aug	37	7,349	0	0	0	12	0	2

Appendix B. Continued.

	Sockeye		Coho		Chum		Pink	
Date	Daily	Cum	Daily	Cum	Daily	Cum	Daily	Cum
18-Aug	356	7,705	0	0	0	12	0	2
19-Aug	87	7,792	0	0	0	12	0	2
20-Aug	193	7,985	0	0	0	12	0	2
21-Aug	170	8,155	0	0	0	12	0	2
22-Aug	1037	9,192	0	0	4	16	0	2
23-Aug	367	9,559	0	0	4	20	0	2
24-Aug	401	9,960	0	0	2	22	0	2
25-Aug	461	10,421	4	4	3	25	0	2
26-Aug	263	10,684	1	5	2	27	0	2
27-Aug	122	10,806	0	5	0	27	0	2
28-Aug	37	10,843	0	5	0	27	0	2
29-Aug	156	10,999	0	5	2	29	0	2
30-Aug	13	11,012	6	11	0	29	0	2
31-Aug	100	11,112	10	21	2	31	0	2
1-Sep	155	11,267	25	46	2	33	1	3
2-Sep	54	11,321	1	47	0	33	0	3
3-Sep	95	11,416	5	52	2	35	1	4
4-Sep	111	11,527	3	55	1	36	0	4
5-Sep	372	11,899	5	60	5	41	1	5
6-Sep	106	12,005	7	67	8	49	0	5
7-Sep	80	12,085	10	77	7	56	1	6
8-Sep	68	12,153	10	87	12	68	1	7
9-Sep	186	12,339	27	114	10	78	0	7
10-Sep	27	12,366	1	115	-1	77	0	7
11-Sep	59	12,425	1	116	0	77	0	7
12-Sep	49	12,474	36	152	0	77	0	7
13-Sep	59	12,533	40	192	1	78	0	7
14-Sep	54	12,587	12	204	1	79	0	7
15-Sep	45	12,632	30	234	2	81	0	7
16-Sep	36	12,668	18	252	-1	80	0	7
17-Sep	9	12,677	25	277	0	80	0	7
18-Sep	16	12,693	12	289	1	81	0	7
19-Sep	12	12,705	13	302	0	81	0	7
20-Sep	3	12,708	54	356	1	82	0	7
21-Sep	-18	12,690	6	362	-1	81	0	7